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AMATEUR PHOTOGRAPHY.

BY

W. I. LINCOLN ADAMS

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HOME PORTRAITURE BY HATCH

AMATEUR PHOTOGRAPHY

A Practical Guide for the Beginner

BY

W. I. LINCOLN ADAMS

Author of "Sunlight and Shadow," "In Nature's Image," "The Photographic Instructor," etc., etc.

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SIXTH EDITION

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To My Father,
WASHINGTON IRVING ADAMS.

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PREFACE TO FIRST EDITION.

In presenting the following chapters on Amateur Photography in book form, the author wishes to make public acknowledgment to the editors of *The Christian Union* and *Outing*, by whose permission they are here reprinted, with necessary revision and additions, from the respective periodicals wherein they first appeared.

The first six chapters were originally printed in the Home Department of *The Christian Union*. Of the remaining chapters, that on Composite Photography was written for *Outing*. The other chapters have appeared in *The Photographic Times*. The tables in the Appendix were collected from various sources, several having appeared in their present form in *The American Annual of Photography*.

The entire matter has been carefully revised, rearranged, and brought up to date. In its present more convenient form it is hoped a wider field for usefulness may be opened than was possible for the articles as they originally appeared.

PREFACE TO FIFTH EDITION.

Since the foregoing preface to the first edition of this little handbook was written, many important advances have been made in the knowledge and practice of photography.

Photographic apparatus and materials have especially been much improved during the past four or five years; and, as a consequence, any work on this subject written in 1893 must necessarily be incomplete and inadequate at the present time, unless radically revised and enlarged.

I had thought to rewrite the entire book before this time, practically discarding all of the original chapters, and adding several on entirely new subjects; but the continued demand for the little manual in its original form suggested that it was still proving useful to beginners, who do not care for, or require, elaborate descriptions of difficult processes or advanced methods of work.

I have therefore concluded to retain most of the

characteristic features of the book as it originally appeared, carefully revising, however, all that is thus retained, omitting obsolete matter, and adding all that is important in a book of this kind of what is new and useful.

In its present revised and enlarged form I am, therefore, in hopes that the little handbook may widen its sphere of usefulness.

W. I. Lincoln Adams.

New York, August, 1899.



FOOTBALL

BY JAMES BURTON



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INTRODUCTION.

THE "FATHERS OF PHOTOGRAPHY."

PHOTOGRAPHY is a child of the nineteenth century. It forms, with the steam-engine and the electric telegraph, the three great discoveries which have made this century momentous. Its actual beginnings, to be sure, date earlier than the nineteenth century; but with the announcement of Daguerre's discovery, August 10th, 1839, the real history of photography may be said to begin.

That announcement was received with the wildest enthusiasm by every one. People flocked to Paris in great numbers to see the beautiful sun pictures which Daguerre had made, and also to learn how to make them. The French government awarded Daguerre an annual life pension of six thousand francs (about twelve hundred dollars) for his invention, and then generously gave the secret to the world.

The new process was called Daguerreotypy, after its inventor, and the business of making daguerreotypes soon became a flourishing one, not only in France and on the Continent, but also in England, and especially in this country. Many improvements were soon made upon the daguerreotype; in England by such men as Fox-Talbot, Scott-Archer, and Dr. Maddox; and in our own country by Professors Draper and Morse, and a German, living in Philadelphia, named Langenheim.

The daguerreotype was not at all like our modern photograph. It was an image photographed upon a copper plate, which could only be seen distinctly by looking at it in a certain direction, and which required, at first, fully thirty minutes' "exposure" in the camera. Think of sitting perfectly still before the camera for half an hour in order to have your photograph taken! And then you could have only one picture, and not, as now, a glass plate from which as many pictures may be printed as you desire. For every picture you wanted in those days you had to sit the full time, though the process was quickened soon after its introduction into general use.

A photograph can be made in these days in the hundredth, and even the thousandth, part of a



second; and any number of pictures can be printed from one glass plate or "negative." The beautiful

colors of nature may be photographed; not in the actual color-shades, it is true, but naturally and harmoniously, so that there is a difference in the shades as seen in the photograph. We can even make pictures at night by means of artificial light; and instantaneously, too, as we shall see in the following chapters.

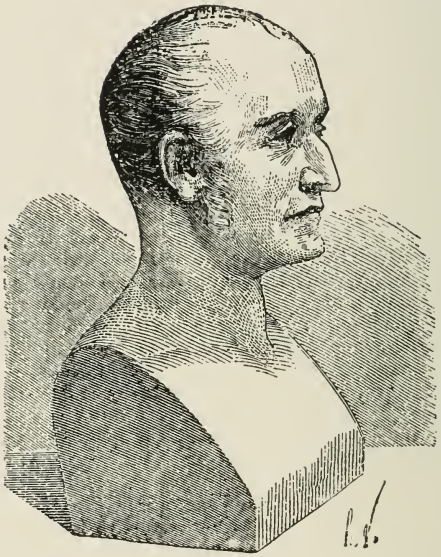
All these wonderful things have been accomplished very recently, most of them within the past ten or fifteen years, though they were foretold, and made possible by experiments, much earlier in the history of photography. But we are progressing too fast, and, before we speak further of the modern almost perfect photograph, should go back to the earlier days, and recall some of the inventions and discoveries which led up to it—even before the time of Daguerre.

Joseph Nicéphore Niepce, another Frenchman, was the first man to obtain a really permanent photograph, though his picture was not so perfect as that produced by Daguerre. Without the assistance which Niepce rendered Daguerre, however, that successful inventor could never have perfected his process. We therefore owe half our gratitude, at least, for the discovery of photo-

graphy to this other Frenchman, who is so rarely spoken of and so seldom praised. The early experiments of Niepce were also the foundation of lithography and the kindred arts now so largely used in illustrating books and papers. Niepce invented a velocipede as well, which is the ancestor of our modern bicycle. In 1829 he made an agreement with Daguerre to continue their experiments together, and this partnership was maintained after his death by his son, Isidore Niepce, who inherited much of his father's genius, and received for the joint invention, from the French government, four thousand francs (or about eight hundred dollars) when Daguerre was awarded his pension of six thousand francs.

The camera was invented by an Italian named Baptista Porta, much earlier than this, though it was not used for photographing. It was in reality merely a dark room into which the light was admitted through a little round hole in one side. The rays of light coming from objects outside of this room entered it through this aperture and made a picture on the opposite side of the room, glowing in all the beauty and color of nature itself, but rather indistinct, and upside down.

This dark room was contrived by Porta about the middle of the sixteenth century. He improved



JOSEPH NIEPCE.

it later by placing a glass lens in the aperture, and outside a mirror which received the rays of light and reflected them through the lens, so that the image upon the opposite wall within was made much brighter, more distinct, and in a natural or

upright position. This was really the first camera-obscura, an invention which is enjoyed to the present day, being situated often upon a hilltop where a picturesque country surrounding may be reflected through a lens which is placed in the center of the conical roof.

Now, our modern photographic camera is merely a small camera-obscura in its simplest form, carrying a lens at one end, and a ground-glass screen at the other. It is, however, often much more complicated in its construction, as we shall learn in the succeeding chapters.



THE PATIENT DONKEY BY THE HON. B. W. KILBURN

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AMATEUR PHOTOGRAPHY.

CHAPTER I.

APPARATUS.

THE first requisite for making good photographs is a good camera. It need not be of complicated construction, highly polished, and correspondingly high-priced. Indeed, the simpler the camera the better, if it be perfectly light-tight and able to do the work which is required of it. So simple a contrivance as a darkened room with a small hole at one end, served for a camera before photography was really discovered, and such a camera made pictures, too, though not photographs.

Now this dark room, or camera-obscura, greatly reduced in size so as to be easily carried from place to place, and furnished with a lens for collecting the rays of light from the subject before it to be photographed, and thus throwing the image of it on the glass plate within and at the opposite

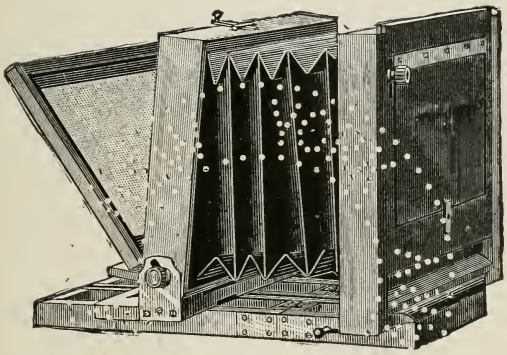
end of the box, is the model of our modern photographic camera, and contains all that is required to make good photographs.

Any one can make a camera if at all handy with tools, though it will probably cost more in the end and will not be so good or so convenient in use as one which may be purchased for a few dollars.

Cameras are very cheap now, good ones of fair size ranging in price from two dollars and a half to twenty-five dollars. Specially made and ornamental cameras of modern dimensions sometimes cost as much as one hundred dollars; while, on the other hand, a complete photographic outfit, including a landscape lens, dry plates, developing and printing materials, may be bought for only two dollars and a half.

The best camera for general use is one which will make photographs four by five inches, or five by eight inches, in size, adjusted for use on a tripod, and which is of a plain pattern and strong in construction.

The above is a picture of a typical camera of this class, from which can easily be learned the use of those necessary parts which every good camera should have.



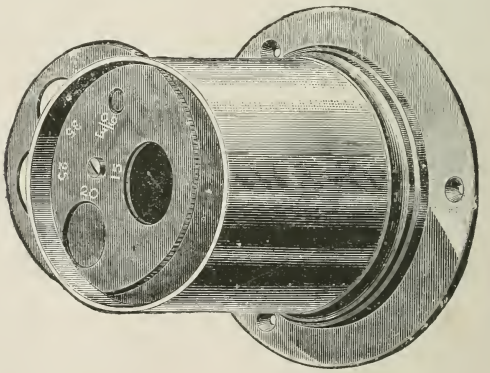
CAMERA.

First of all, a camera should be as light and compact as is consistent with a fair amount of strength. It should be capable of reversing, so that an upright picture may be made when the character of the subject requires it. In the one illustrated this is accomplished by turning the camera on end and securing it to the tripod by the screw, which also fits into a plate on the side. The front-board which bears the lens should be capable of moving upward and downward, so that more or less of the sky or foreground may be taken in the picture by simply moving the lens upward or downward. And then what is called a "swing-back" is also a great convenience, as it enables the photographer

to point his camera upward or downward in order to take in a high building or the ground very near his feet.

The front part of the camera which bears the lens is connected with the back part which holds the plate by means of an elastic bellows, so that a "sharp" focus—by which is meant clearness of the image on the ground glass—may be obtained by moving the plate nearer to or farther from the lens. Just how to focus, however, we shall learn when we go into the fields with our camera.

The lens is a very important instrument, as it forms the image of the picture to be photographed on the sensitive plate. It should be selected with



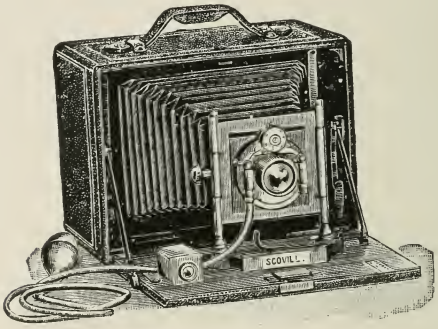
LENS.

the utmost care, and if only a moderate amount of money can be spent on the outfit, we should advise economizing on the camera rather than on the lens. There are many kinds of lenses, and they vary in price from three dollars and a half to fifty or even seventy-five dollars, for the size of cameras we have been considering. A good "single view" lens, as it is called, costs only four dollars and a half, and is perfectly capable of making the best landscape photographs, as well as groups of one's friends, and portraits; but it will not make instantaneous pictures unless the light is very strong and the plate used is very sensitive; and it cannot make photographs of interiors, as the picture of one's room or the inside of a church.

For interior work a wide-angle lens must be used; and for instantaneous photographs one which is called a "rapid rectilinear" lens, which means that it is very quick-working and makes an image with perfectly straight lines, as the original subject appears in nature. Such lenses of domestic make, which are now in every way the equal of the best imported lenses, cost from twenty-five to seventy-five dollars.

Most amateurs will probably prefer a more com-

plete camera than the one described heretofore, as they will undoubtedly wish an instrument which can do what is called "snap-shot" work, as well as make ordinary landscape and time pictures.

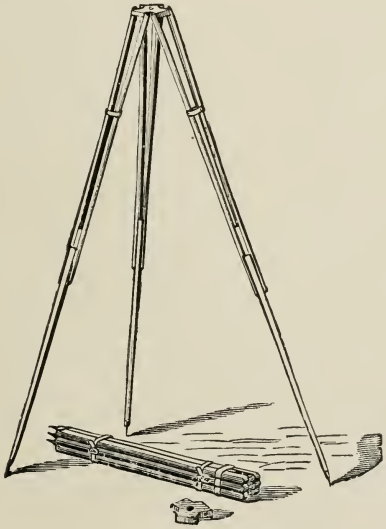


HAND CAMERA.

Such a camera is shown in the accompanying illustration and is a good example of the most modern type of hand cameras. It can be used on a tripod for exact work, or in the hand for quick exposures, as may be desired. Being of the folding type, it is very compact and portable, and it contains all the adjustments and attachments which are required for the most advanced work. This camera, or one like it, will be found practically in-

dispensable for work in instantaneous photography, which is described in a later chapter.

The other necessary piece of apparatus is the tripod. It should be light but strong, and capable of being lengthened or shortened so as to overcome unevenness of the ground, as the camera must always stand perfectly level.



TRIPOD.

A tripod does not cost very much, the very best being priced at three dollars and a half. It is

easily put together and taken apart, and does not require any special description at this time.

There are many other things which go to make up a complete photographic outfit, but just now we need not regard them. We have examined the essential parts of a working equipment, and are prepared to go into the field and make our pictures. When we are actually engaged in the work of photographing we shall learn more about the outfit and how it should be used.



WHERE THE OLD ORCHARD SKIRTS THE HIGHWAY BY W. I. LINCOLN ADAMS

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CHAPTER II.

IN THE FIELD.

HAVING carefully examined our apparatus, let us now wander afield and try our skill at making pictures.

What shall we photograph first? Let us look about us, and see what most attracts our attention. There are pretty subjects on every hand, and many of them will make beautiful photographs, though we cannot "take" them all at this time of day, with the light falling as it does. We can only photograph those subjects which lie in front of us when our back is turned toward the sun. That little meadow brook straying along by the old tumble-down, vine-covered pasture-fence yonder makes a pretty picture and one that is easy to photograph. Let us set up our camera and look at it through our lens.

First, we must unstrap the tripod and adjust it. This is easily done by setting it up and then spreading the legs so that one comes exactly in front of us and one on each side. Now take the

camera from its carrying case, and secure it firmly on the tripod by means of the "set" screw, which protrudes up through the tripod top and into the bottom or "bed" of the camera. Then adjust the lens (which comes packed reversed in the camera) so that it faces outwards from the front-board, right side up. Our apparatus is now ready for use; but before we can make our photograph we must "focus" the image upon the ground glass of the camera.

This is done by excluding all surrounding light by means of a black cloth thrown over the operator's head, and held closely around the camera and underneath it. Take the cap off from the lens, and you see but a blurred image, upside down, on the ground glass focusing screen in front of your face. Move the glass a little nearer the lens, and the image may become somewhat more distinct. If it does not, you must draw the glass toward yourself and away from the lens, when the picture will surely grow clearer. At a certain point the image will appear most clear, or "sharp," as photographers say. If you go beyond this point the picture will grow indistinct, and if you do not reach it the image will continue to be dim;

so that it is easy to determine just where the ground glass should be secured, for there the picture is clearest. This point is called the "focus," and here the frame which carries the ground glass, and, later, the plate-holder containing the sensitive plate, is fastened by means of a little thumbscrew. Having accomplished so much, we may proceed to examine the inverted picture on the ground glass as to its artistic composition.

On looking at the subject we have chosen, on the focusing glass, we find that we can decidedly improve our picture. We should have more foreground and not nearly so much sky, and the pretty little clump of trees on the extreme right of our picture should be brought into view, in order to balance the old fence with its weeds and vines on the left. We take in more foreground and shut out more sky by lowering the front board which bears our lens. The graceful elm trees are brought into our picture by simply turning the camera a little to the right, on the tripod, without moving it in any other way.

We are now ready to make the "exposure," as photographers say. First we recap the lens, and then in the place which the ground glass occupied

we fasten one of our plate-holders, which was filled with two plates in the dark room (one on each side), and throw our focusing cloth over the camera to exclude any light which might leak in. On such a bright morning as this, with the medium-sized aperture in our landscape lens, and a sensitive plate in our plate-holder, four seconds will be ample time to sufficiently impress the image of the beautiful picture before us on our plate in the camera. In timing an exposure I find it easier to count double the number quite rapidly than to count the exact number of seconds more slowly. (One can easily determine just how fast one should count by timing one's self with a watch.) Draw the slide from the plate-holder which is nearest the lens, so that the plate within has nothing between it and the subject except the cap on the lens. When this is taken off, the light transmits our picture through the lens and on to the sensitive plate. As you remove the cap from the lens, carefully, so as not to jar the camera, count "one," and place it over the lens again when you say "eight." The slide should now be re-inserted in the plate-holder, but this time with the exposure side out, so as to prevent exposing the same plate again.

When one is not quite sure how long to expose a plate on a certain subject, it is well to use a second plate on the same subject, giving it a different time, longer or shorter, and note in developing afterward which plate makes the best negative. Thus one learns by experience how long a time to give one's subjects under certain conditions of light, and a guide is formed for future trials.

But we do not need to expose a second plate on this view, as it is quite certain four seconds will be enough; and if it should prove too long a time, we can "restrain" the development by means which we shall learn when we go into the dark room. Let us continue our search for the picturesque, and expose the five remaining plates which we have in our holders. We must remember, however, that a photograph should only be made with the sun shining from behind the camera or at one side. We cannot photograph successfully with it shining directly into our lens; at least, in the beginning. And we should choose the simplest subjects at first—landscapes and other stationary objects. We shall then be the better

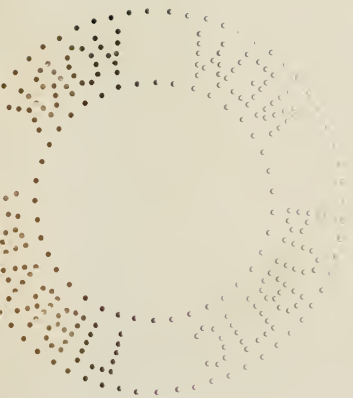
prepared to photograph more difficult subjects, as they present themselves in the future.

With film and "snap-shot" cameras all this matter of exposure is very much simplified, as one has, practically speaking, merely to "press the button," as it were, and let some one else "do the rest." But I am assuming that my readers wish to do it all themselves and I therefore strongly recommend the use of plates, especially in the beginning.



MOONLIGHT BY J. L. NIX

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CHAPTER III.

IN THE DARK ROOM.

It now becomes our pleasant duty to "develop" as it is termed, in a dark room, the sensitive plates which we "exposed" in our camera in the fields. But before doing so we must fit up a dark room and prepare the solutions.

A dark room may easily be improvised by the amateur. Any room from which all rays of sun or white light can be excluded will answer the purpose perfectly well. The bathroom or kitchen may be used in the evening, and are very convenient, too, for here we can use running water and have plenty of it. It is only necessary to light our ruby lantern (which came with the outfit), unpack our trays and wash them, and make our solutions according to the directions which are given.

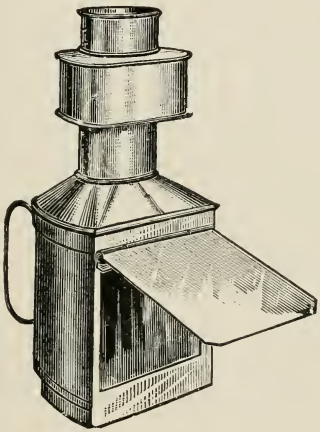
Where running water cannot be had, as, for instance, in a dark room fitted up in the cellar, garret, or barn, or when we are using a spare closet for a developing room, or even one's own bedroom, we must add to our outfit a large pail for holding

fresh water, and another pail or slop-jar for receiving the waste water and old solutions.

Unless we have a dark room which is perfectly light-tight, we can develop in it only after sundown, for if a single ray of white light reaches our sensitive plate it will be spoiled at once. Red light, however, does not affect the sensitive surface of photographic plates or paper, so we can develop by it with perfect safety. The photographer can make his own red lantern without much trouble and expense, but a very convenient little ruby lantern, giving a good light to work by, can be had for a dollar and a quarter, and even cheaper ones may be purchased for fifty cents.

When one is so fortunate as to have a specially made dark room which is absolutely light-proof, one can develop in it by day as well as at evening, by simply covering one window, or a small portion of the window, with a sheet of ruby glass or paper. The white light which then passes through the window becomes red before it enters the dark room, and so is perfectly harmless to all photographic operations. At night, of course, the lantern must be resorted to, the same as in the case of the other dark rooms mentioned.

A complete developing outfit should contain, in addition to the ruby lantern which we have already spoken of, two trays of the proper size, a 4-ounce glass graduate and a minim graduate for measuring our solutions, and a small pair of scales. The chemicals required are: a package of



THE RUBY LANTERN.

dry plates (which, of course, were purchased with the camera), a pound of hyposulphite of soda, a pound of alum, an ounce of bromide of ammonium, and a package of developer containing two solutions. A bottle of negative varnish is sometimes

included, though for most amateurs' purposes it is not necessary to varnish a negative.

Having found and fitted up the dark room with the utensils and chemicals enumerated, we are ready to develop our first plate.

There are many developers in the market already prepared for the amateur's use, and it is fully as well, at least in the beginning, and more economical to use one of these ready-prepared developers instead of making your own. First, at least, learn the use of the reliable one, consisting of pyrogallol, carbonate of potash, sulphite of soda, and other substances. In case any one should want to make it for himself, I give the exact formula. It is composed as follows:

A.

Pyrogallol	1 ounce
Sulphite of soda (crystals)	4 ounces
Sulphurous acid	4 ounces
Water	10 ounces

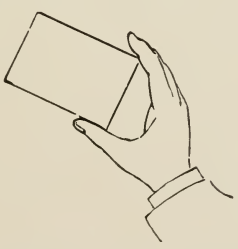
B

Carbonate of potash	3 ounces
Carbonate of soda (granulated)	1 drachm
Water	10 ounces

The developing solution is formed by taking one drachm each of the above solutions, A and B, to one ounce of water. It will be found more con-

venient and more economical to buy the developer already prepared, as has been said. It comes in two solutions, and the developing bath itself is composed as was just stated. Let us proceed to try it on the first plate which we exposed.

We take up one holder containing the two plates, and carefully remove one from the holder, and place it in a tray filled with pure water. Here we allow it to soak for a few moments, and then immerse it in the developing solution which we have just made, and which is contained in the other tray. In handling the plate, be careful not to touch the sensitive side, which can easily be determined by its appearance, even in the dim ruby light, for the back of the plate is plain glass and glistens, while the sensitive side has a dull appearance. It should be held by its edges, as shown in the accompanying sketch.



HOLDING THE PLATE.

The image should not be long in making its appearance. At first a dark streak will be observed in about the middle of the plate, and soon all the upper (or lower) half of the negative will gradually darken. This is the sky, which, being most bright in nature, affected most strongly the sensitive plate, and is therefore first to make its appearance. Soon, however, the details of our picture, even in the shadows, will begin to appear, and we observe with breathless interest the beautiful landscape grow into being as we observed it first upon the ground glass of our camera. We must wait patiently, however, gently rocking the tray which contains the developer all the time, until the image is fully out, and the milky-white appearance of the plate is changed to a dark gray color. When the plate is fully developed we must remove it from the developing solution and wash it in two or three changes of water. It is now ready for the "fixing bath." But before describing that process, it may be well to consider for a moment how we should have acted in case our plate had not been correctly "timed" in the exposure.

If the exposure had been too long, the image

would have flashed up suddenly as soon as the plate touched the developing solution, and we could not have saved it from being a weak, "flat" negative, as it is termed, unless we were ready with our bromide of ammonium solution to add several drops to the developer, and some more of the "A" solution. The bromide of ammonium is composed by dissolving the contents of the ounce bottle in ten ounces of water.

If, on the other hand, our plate had not been exposed long enough in the camera, the picture would have been very slow in making its appearance, and the finer details, especially in the shadows and dark portions, would have failed to come forth. It would then have been necessary to add half a drachm or more of the "B" solution to the developing bath. It must be understood that the "B" solution accelerates development, while the "A" solution retards it. When the developed negative has been rinsed off in clear water, we place it in the hyposulphite of soda solution, where it is "fixed."

The "fixing" bath is composed by simply dissolving four ounces of the hyposulphite of soda in twenty ounces of water. Place the developed

negative in this solution and allow it to remain there until the opaque yellowness has entirely disappeared from the back of the plate. It will require from five to fifteen minutes to accomplish this, and it is well to leave the plate a little while after it becomes perfectly clear rather than remove it too soon, for if the negative is not perfectly "fixed" it will afterward gradually turn yellow.

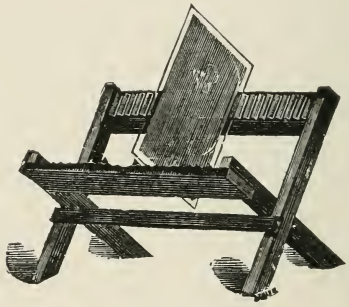


PLATE-RACK.

I must here caution the amateur never to use the tray which contains the fixing solution for any other purpose. You cannot wash it so clean but that a slight trace of the "hypo," as it is called, will remain, and if that comes into contact with the plate during any previous process it will surely spoil it.

After the negative has been thoroughly "fixed," it only remains to wash it very carefully in several changes of water, when it is ready for drying, and, later, for printing. In the summer time it is often well to soak the negative at this point, for a few minutes, in a solution composed of alum and water. This hardens the film and prevents it from "frilling" about the edges of the plate. The alum or hardening bath is composed by dissolving two or three ounces (the exact amount is not material) in several ounces of water.

When the plate has been thoroughly washed in three or four changes of water, or, better still, in a continuous gentle stream of running water, for, say, fifteen minutes or so, it should be set up to dry in a secure place. While it is drying, we will take up our second plate and proceed in the development of it as in the first case, and so on until all the plates which we exposed have been developed, fixed, hardened, and washed.

Of course, if the amateur wishes, he can send his plates to a professional who will develop and print them for him, and where film cameras are used this is usually done, but I think it always better to develop one's own plates, even if they

are afterward sent out for printing, for in so doing one learns much as to exposure, etc., and development, also, will be found the most fascinating part of photographic pastimes.



WEED BURNING

BY W. G. J. HENSLER



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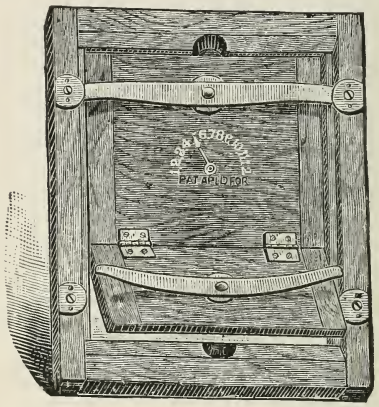
CHAPTER IV.

PRINTING AND TONING.

We left our developed plates in a secure place, drying. As the sun shines brightly to-day, let us take them from the drying racks and proceed to make some prints from them.

For this purpose we must employ the printing frame which came with our outfit. This is a wooden frame which exactly takes the negative. After the plate has been placed in it, film side up, a sheet of printing paper is laid on the negative, sensitive side down. The wooden back is then put in, and secured at both ends by the brass springs, as shown in the cut. This back is hinged in the middle, so that it may be partly turned back and the progress of the printing process examined without moving the paper on the plate. When the plate and the paper have been firmly secured in the printing frame, it is exposed to the sunlight, on a window-sill or elsewhere, care being taken to avoid any shadows falling upon its face from shutters or other projecting parts. In bright sun-

light, one minute is usually long enough to thoroughly impress the picture on the sensitive silver



THE PRINTING FRAME.

paper through an ordinary glass negative; but the print must be a little darker than it is desired to be when finished, as the toning, fixing, and subsequent operations bleach it somewhat. We can easily determine just when to remove the print from the negative by taking the printing frame from the sun, and, in subdued light, observing how dark the print has become. This is done by unhinging one side of the back and lifting that part of the print thus released from pressure. When

the print is dark enough, remove it from the printing frame to a box or drawer, where no light can get at it. Repeat the operation until as many prints are made from the negative as are desired, and then put another negative in the frame, removing the first one, of course. Make the required number of prints from this negative, and so on until all the prints are made that are wanted. We are now ready to take them from the box where they have been concealed from the sunlight, and proceed with the toning and fixing processes. But before we take up these interesting operations it would be well to know something more definite about the actual printing itself.

The negative, as we know, is made up of more or less opaque and transparent portions; clear glass on the one hand, shading into absolute opaqueness on the other. And the whites of the negative correspond to the darks of the original picture, because the light, being weakest from the dark portions in the picture in nature, affected in the least degree the sensitive film of the plate, and thus left it nearly or quite clear glass. In like manner, the bright spots of the picture reflected most light through the lens to the sensitive plate,

and therefore darkened it. In proportion as the parts in nature are dark or light, just so are the images on the photographic plate light or dark. We can, therefore, understand how the print will be exactly the opposite of the negative again, and like the original subject in nature.

The light will pass most freely through those parts of the negative which are clearest, and thus will blacken the paper beneath to the greatest degree. Where the negative is dense and opaque very little light can pass through, so that the paper retains its original whiteness under those parts. Thus we obtain on the print the reverse of the negative, or a "positive," as it is called. Positives may be made not only on paper, but also on glass, when they are called transparencies, or lantern slides, and are used for hanging in windows or for enlargement through a magic lantern or stereopticon. Then we have "blue" prints, bromide prints, platinotypes, aristotypes, and chloride prints, according to the kind of paper which is used for printing the picture by sunlight through the glass negative, and some of these processes are treated in later chapters. Printing from a glass transparency, which is a positive, of course

obtains a negative; and sometimes negatives are made on paper for certain purposes. As many prints as are desired can be made from one negative, for the operation is the same every time, and nothing is taken from the negative; the light passing *through* it makes the picture.

We have learned in this chapter only one printing method, the simplest of all, but the one yielding, perhaps, the most beautiful pictures. It is called "silver printing" by photographers, because the paper on which the prints are made was sensitized to light by coating it with a solution of nitrate of silver. The amateur can make his own silver paper without much trouble, though perhaps it is better at first to buy the paper already prepared. It comes in packages of two dozen sheets, cut to the different sizes of the negatives, and one package came with our outfit. Having learned how to make prints by this method, we will go on with the toning and fixing process, and finish the picture we have commenced.

We left the batch of untoned and unfixed prints in a dark box. We must now take them from their hiding-place, and place them, one at a time, in a tray of pure water, face down. The

tray which comes with our printing outfit will hold fifteen or twenty prints. While they are soaking there we will prepare the toning bath as follows:

Dissolve in fifteen ounces of water fifteen grains of chloride of gold and sodium, and pour three ounces of this solution into another tray, adding a few drops of a bicarbonate of soda solution. Then add a pint of water to the toning bath and twenty grains of acetate of soda. After the solution has stood for a few moments it is ready for use.

The prints are transferred from the water bath to this solution, facing downward as before, and are moved about so that they will not stick together. In ten or fifteen minutes the reddish color which the prints assumed in the pure water will begin gradually to change until a rich purplish-brown color is obtained. The prints must not be removed until this stage has been reached, but, on the other hand, they must not be allowed to remain so long in the bath as to acquire a bluish or slaty color.

After the prints have acquired the desired shade, take them from the toning bath and rinse them off in another tray of pure water. Then

immerse them in the fixing bath, which is composed as follows:

Hyposulphite of soda.....	1 pound
Carbonate of soda.....	1 tablespoonful
Common table salt.....	1 tablespoonful
Water.....	5 pints

In this fixing bath the silver compound which forms the image of the prints is "reduced" so that pure metallic silver remains, which is permanent and will not fade. It generally requires about fifteen minntes' soaking in the fixing bath to thoroughly accomplish this result. The prints are then removed and thoroughly washed again, for if the slightest trace of hypo is allowed to remain in the film it will gradually turn yellow on exposure to light and ruin the print. As in the case of the negative fixing bath, so here, the tray holding the solution should never be used for anything else, for the hyposulphite of soda is very difficult to remove, even by the most thorough washing.

The final washing is of the utmost importance, as on it depends to a great extent the durability of the prints. They should soak in a tray of clear water for several hours, the water being changed

a number of times during that period. Some amateurs allow their prints to remain in water over night and remove them in the morning after a thorough rinsing. In the final washing the prints should float face downward, so that the hypo will dissolve out of the film more easily, but in the toning process they may be turned upward from time to time in order that the progress of the process may be observed.

After the final washing the prints are hung up on a line to dry, or laid between blotters, and then they are ready for "mounting" upon cardboards or in an album. This is done by covering their backs, while still wet, with a thin layer of flour or starch paste, and then placing them upon the cardboard, paste side down, rubbing them closely to the mount by means of a paper placed on the print. A gloss may be given the mounted prints by running them through what is called a "burnisher;" but the print must be perfectly dry before this is done.

The various baths, such as the toning bath, and others referred to in this and other chapters of this book, can be procured from the dealers in photographic materials already prepared, with

printed directions for using; but at first I think it is well to prepare one's own solutions as it familiarizes one with their constitution and so makes one more intelligent in their use.



REFLECTIONS BY J. L. NIX



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CHAPTER V.

THE PLATINOTYPE.

In the preceding chapter only one printing method was described, the original silver albumen process. In this chapter I write to describe the platinotype, because it lends itself especially to the "art side" of photography.

It may be understood that whatever effect is aimed at, or desired by the worker in his finished prints, may be obtained with this paper; *i. e.*, he may secure gray prints with detail in both shadows and high lights; and with the same paper (but not the same negative) strong, vigorous, black and white prints, depending altogether upon the density of his negatives. He will soon learn that from thin negatives gray prints will result, and from strong negatives, more brilliant prints.

The sensitized paper is sent out in tin tubes, having the lid sealed with rubber tape to keep out the air. In the tube with the paper will be found a small lump of preservative (calcined calcic chloride) to absorb any moisture that may have

been in the tube at the time of packing, or that may have leaked in afterwards. This preservative need not be disturbed or taken out of the paper in which it is packed, otherwise particles of calcium dust may get upon the fingers, or come in contact with the sensitized paper and cause white comets to appear in the finished prints. Cleanliness in every particular is essential in working platinotype. Negatives that have been intensified with mercury should be varnished before coming in contact with the paper; hands must be clean; the table, or bench on which the frames are filled, should be kept dusted. Careful attention to these details will prevent spoiled prints.

The paper is yellow in color and more sensitive to light than the printing-out silver papers. The paper may be taken out of the tube and the printing frames changed in a room lighted by gas light, incandescent electric light, or a clear yellow light. It is better to take out of the tube only as many pieces of the paper as it is intended to use at one time, and to immediately return the balance of the paper to the tube together with the preservative, wrapped just as it is, without shaking it, and re-seal the lid with rubber tape, or a wide rubber band, to make

the space between the lid and the tube air-tight.

First rub the film of the negative with a piece of cotton, or a handkerchief, to remove any dust there may be clinging to it, and place it in the printing frame, then upon it the sensitized paper, and lastly the rubber pad, or in place of the rubber pad, paper or felt backing that is perfectly dry. Expose in either sunlight, or shade; the former, being much the quicker, is more suitable for strong negatives. The length of exposure will depend upon the density of the negative, but, when the detail is visible in the middle tones, the print may safely be taken out of the frame, and put aside for development, but remember that the exposed image from a thin negative should be *less visible* than from a denser one.

Having exposed a test print, or as many prints as are desired for the time, development should be proceeded with the same day, otherwise the tone of the prints may be brown, or muddy, and the picture less brilliant. The developing crystals are dissolved in hot water, and allowed to cool. The whole package should be dissolved at one time, and if the water contains alkali, or much organic matter, distilled water should be used. A

large quantity of developing solution may be made up at one time, but that which is used from day to day need be only a few ounces, and may be added to from time to time from the unused stock solution; but once the solution has been used, it should be put in a separate bottle and kept in a closet away from strong daylight. Gas light does not do a particle of harm to the exposed prints, the sensitized paper, or the developing solution, and the development may safely be conducted by it. The development of the image is quite rapid, and if it be possible to put the exposed print on the solution without getting air-bells, or bubbles, to do it quickly and evenly, and to allow the print to remain quite still for a few moments, it is the best method of development, but the print may be immersed in the solution, either face up or down, and development stopped when the detail in the middle tones and high lights is well defined. The print dries up slightly darker than it appears when wet.

The acid clearing bath is made by adding one ounce of chemically pure muriatic acid to sixty ounces of water.

When the development of a print has ceased,

drop it at once into the acid clearing bath. It should *never* go into plain water first. The object of this acid clearing bath is to take out the yellow color (iron) from the paper, otherwise the prints in a few months will turn yellow. It is important to subject the prints to three of these acid baths, and four are better for a large number of prints. The heavy papers should never have less than four baths, and if there are many prints, five baths will not be too many, and the prints should be allowed to remain in each bath from five to eight minutes. During the washing of the prints in these acid baths the surface of the paper becomes somewhat tender and may easily be rubbed. To avoid this, use a goodly quantity of solution, and do not drag the prints one over the other. After the acid baths, the prints may go into plain water and be washed four or five times, and the same care in regard to rubbing applies here. Use plenty of water. The prints may then be taken out and hung up on clips to dry. Use Lockwood clips and put two prints together—back to back, and when dry, they will be flat. When the prints are dry, they may be trimmed and mounted in the

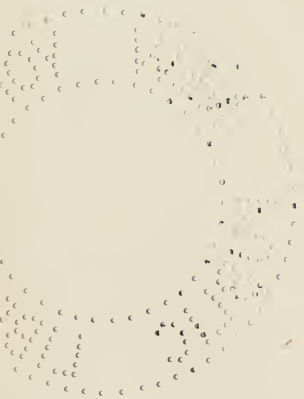
same manner as other prints, on any kind of cardboard that suits the taste of the worker.

The quality of the negative has all to do with the character of the finished print. As I have before indicated, the thin negative will give a gray print, and the denser negative a brighter print, and it must be left to the taste of the worker to decide just the kind of prints he prefers, and this he may control by the suitable development of his negatives. I have always inclined to a pyro developer, but everyone may not approve of it because of its staining propensities; but much of the staining may be overcome by the use of rubber finger tips, or gloves, though both are unhandy, and so possibly the only thing to do is to advise the use of the developing agent that suits the user. If his negatives and prints please him, nothing more need be said. It may be well, though, to say that the plate-makers publish developing formulæ, which are supposed to be the very best for their particular plates, and as they give these for both pyro and other developers, I advise that the worker follow the instructions that come with the plates.



AN EVENING AT HOME

BY GRAY



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CHAPTER VI.

BROMIDE PRINTING.

THE general subject of bromide printing has always been popular with amateur photographers. Lately there has been introduced by certain manufacturers an improved paper which is simple to work and very similar in its results to platinotype prints. The paper is much cheaper, however, than the platinotype and much easier to work than the original methods of bromide printing. It is called in the trade "Velox," and is made in six different grades: "Carbon Velox," a matt paper; "Glossy Velox," an enamel surface paper; and "Rough Velox," which is a rough surface paper. These three grades are designed for use with soft negatives, where effects of greater contrast are desired. The next three grades which I shall mention are designed for soft effects, to be used with negatives which already possess strong contrast. They are the "Special Portrait Velox," which is a partial matt surface paper; "Special Glossy Velox," which is an enamel surface paper;

and "Special Rough Velox," possessing a rough surface, as its name indicates.

I will now describe how the paper is used in actual practice. Open the package of paper in gas-light or in subdued daylight only, and apply it to the negative in the printing frame the same as in the case of other papers. An average negative requires an exposure of from one to eight seconds to diffused daylight a few feet away from a northern window; electric arc-light requires about the same exposure; an ordinary gas-jet or kerosene lamp, at a distance of three or four inches from the negative, will yield a print in one or two minutes; Welsbach burners allow quicker printing. Very dense negatives require more time, while very weak ones require less. All "Special Velox" papers require less time than ordinary Velox. Use a strip of paper to ascertain the proper length of exposure before proceeding with regular printing, and keep your printing frame always at the same distance from the light.

The development of the paper can be accomplished by using either of the following formulæ. Be sure, however, to have your chemicals pure, especially your sulphite, and not let your devel-

oper become spoiled by oxidation; therefore keep it in small, well stoppered bottles filled to the neck. Rubber stoppers are recommended. Too weak a developer, or one that is oxidized or contains too much bromide, will give greenish or brownish blacks. It is almost invariably necessary, in order to prevent foggy or stained whites in prints, to add a small quantity of a ten per cent bromide of potassium solution to the developer. This quantity will vary according to the purity of the chemicals and water, and according to the age or the conditions of dryness of the paper. "Special Velox" can stand more bromide in the developer and further dilution of same than ordinary Velox without giving greenish blacks.

METOL QUINOL.

Water	10 ounces
Metol	7 grains
Sodium Sulphite, crystals pure	½ ounce
Hydroquinone	30 grains
Sodium Carbonate, dessicated	200 grains
or crystalized	400 grains
Bromide of Potassium, 10 per cent solution, about	10 drops

AMIDOL.

Water	4 ounces
Sodium Sulphite, crystals pure	200 grains
Amidol about	20 grains
Bromide of Potassium, 10 per cent solution, about	5 drops

If blacks are greenish add more amidol; if whites are grayish add more bromide of potassium.

The developer should be fresh and strong, with just enough bromide to insure pure whites. Before developing dip the print in pure water for one or two seconds. With any of the indicated developers development is very quick, except with "Special Velox," and takes only a few seconds. You can use a tray, as for a dry plate; or, if you prefer, the exposed print may be put on a glass plate and the developer spread abundantly over its surface by means of a brush or a tuft of cotton. The image will appear suddenly; somewhat more slowly for "Special Velox" papers. As soon as it is strong enough dip quickly into water and throw into the hypo acid fixing bath (see formula below) in which you should keep your prints moving during the first few seconds, so as to insure uniform fixing, thus preventing stains and yellow whites.

The prints are fixed in the hypo acid fixing-bath given below, and require ten to fifteen minutes to accomplish this process. Then wash the prints from twenty minutes to an hour in running water.

The following is the fixing-bath recommended by the manufacturers:

Hypo	16 ounces
Water	64 ounces

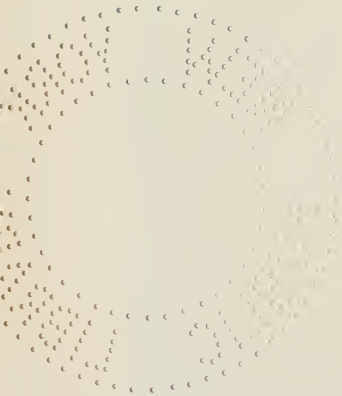
Then add the following hardening solution:

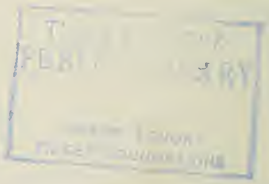
Water	5 ounces
Sodium Sulphite, crystals	½ ounce
Acetic Acid, No. 8 (or about 4½° B.)	3 ounces
Alum, powdered	½ ounce

This hardening bath may be left out; but the surface of the prints may then remain rather soft, and the hypo bath will soon discolor and is then likely to stain the prints. With the hardening solution this mixture keeps perfectly clear, and can be made up at any time in advance. It can be used as long as it is strong enough. It is also an excellent fixing bath for dry plates.



"HAPPY LITTLE ARKANSAS COON."




FEB
RY

CHAPTER VII.

OTHER PRINTING PROCESSES.

MENTION was made, in a preceding chapter on printing, of several other processes, and I have undertaken to describe one or two in another place in this book. In this chapter I wish to conclude the subject of printing by describing the method of making photographic prints on a gelatine "printing-out" paper, or "aristotype" as all this class is termed in the trade, and also "Blue" prints as they are called.

In the first place it must be understood that the prints are made exactly the same as in the case of albumen prints, *i. e.*, a little darker than the finished picture is desired to be, so that the slight fading in the toning and subsequent processes will bring the finished print to the desired depth of color. After the prints are made they must be carefully washed in three changes of water, until all free silver is removed; they are then ready for the toning bath.

Any good toning bath which has been made

slightly alkaline with bicarbonate of soda, or with a mixture of borax, and acetate of soda, can be used. The bath recommended by a well known manufacturing company is composed as follows:

Chloride of gold.....	2 or 3	grains
Water	30	ounces
Acetate of soda.....	1 to 1½	drachms
Borax.....	25 to 30	grains

The toning bath should be sufficiently strong to tone prints in from four to eight minutes. If not strong enough to accomplish this, use more gold. If too strong, it can be diluted by adding a little water. The alkalinity of the bath must be tested with litmus paper, so that the operator knows exactly the condition of his toning solution in this respect. After toning, the prints may be put immediately into the fixing bath, but what is known as a "short-stop" can be used to check toning at this point. This "short-stop" is composed of water made acid with acetic acid.

The fixing bath of hyposulphite of soda should be fresh and of the following strength:

Hyposulphite of soda.....	1 ounce
Water.....	25 ounces

allowing the prints to remain in this fixing bath

about fifteen minutes. If it is desired to harden the film on the prints, especially in warm weather, it may be done by adding one ounce of bisulphite of sodium to every five ounces of hypo, and one ounce of a saturated solution of chrome alum; but the bisulphite must be added first in order to avoid the bath becoming milky. After fixing, the prints should be allowed to soak an hour or so in running water and should be kept separate, or given a number of changes of water of a few minutes' duration.

Many amateurs prefer to use a combined toning and fixing bath in order to simplify the process, and any good combined bath formula can be used in connection with this paper. The manufacturers, however, positively insist that up to the present time there is no printing-out paper in existence which will give prints of a reliable permanency, in a combined toning and fixing solution, and they, therefore, do not recommend a combined toning and fixing bath. If there be those, however, who wish to use a combined bath, I can recommend for that purpose the following formula:

Warm water	1 quart
Hypo	8 ounces
Sulphocyanide of ammonium	1 ounce
Acetate of lead	6 drachms
Citric acid	2 drachms
Powdered alum	2 drachms
Pure chloride of gold	6 grains

Dissolve thoroughly in the foregoing order, then let stand for twenty-four hours to settle, and use the clear portion.

This bath should not tone in less than three or four minutes; if it is not cold enough it will tone too quickly and in this case cool it. After this bath becomes exhausted add new bath to it. Do not tone as far as required, as the prints dry up considerably darker. After toning throw the prints directly into a good supply of *fresh and cold water* which should be changed frequently, and in which the prints should be kept moving.

Mounting and burnishing are accomplished as usual, although in this connection the manufacturer recommends the use of castile soap as a lubricator.

Another process is that of making "blue" prints on ferro-prussiate paper. This has always been a very popular paper with amateurs, because of its extreme simplicity.

Simply print until the deepest shadows become a slightly bronzed color, but not until the whole picture shows out clearly in bronze, as this will spoil the half-tones and lose detail.

Remove the paper from the frame and place it in clear, fresh water, in subdued light. Change the first water after five minutes, and wash in frequent changes of water for twenty minutes more, and if prints are not to be mounted, hang up to dry. When the prints are to be mounted, place them between clean blotters until surface dry, and mount while still damp.

Don't wash the prints for less than twenty minutes, and avoid over-printing, as the paper does not gain its full depth and brilliancy until the prints are thoroughly dry.

The prints should not dry "dead," but become more brilliant in color after several hours.

If the paper washes down too light after being twenty minutes in water, the exposure must be lengthened. Do not reduce the amount of washing, as the water does not bleach the print but makes it more permanent if the exposure has been correct.

Store your paper in a dry place, and do not

handle it in white light, as even subdued light will injure its tones and keeping qualities.

The prints are a beautiful blue and white, very permanent, and especially convenient as "proofs."



A MEDALLION PORTRAIT BY MORENO

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CHAPTER VIII.

PORTRAITURE.

PORTRAIT-MAKING by photography is one of the most interesting of pastimes. It is not necessary to have a regular studio, with skylight, painted backgrounds, and papier-maché accessories, in order to make good likenesses of your friends with the camera. The light from an ordinary side window in your home will answer very well; and for a background a large sheet of brown wrapping paper will serve. Real furniture looks better in a photograph than the imitations which are used in the professional studio, and there is no reason why the amateur should not make as good portraits of his friends as the professional photographer.

Select a room with plain white or painted walls for your studio, if such is to be had in the house; and it is better if the windows are on only one side. If possible, have the windows face the north, for then the illumination is the same throughout the day, the sunlight at no time entering a window which faces due north. If the walls of your im-

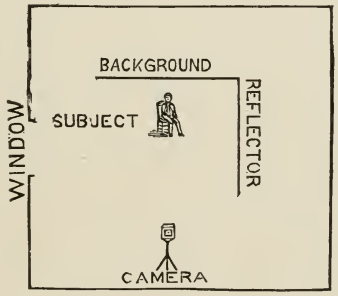
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provised studio are papered with brilliantly colored figures, you must use a background in all cases. A good one can be made by stretching some dark woolen material over a clothes-horse or other suitable frame. Or, as has been suggested, plain brown wrapping paper may be used if a large enough sheet can be obtained to cover at least one side of a clothes-horse or similar frame. If the clothes-horse is divided and hinged in the middle, as is very often the case, the other panel may be covered with a white cloth or paper, and will serve very well as a reflector. If the wall is plain white or of a gray color, there is no absolute need of a background, for the wall will answer very well, and then one need make but a reflector in order to be ready for work. The reflector is of white material, so that by being placed opposite the window through which the light enters to illuminate the subject, the darkened side of the face is lighted to a certain degree, and thus a more even illumination is given the portrait. If there are windows on two sides of the room, all but those on the one side must be closed by means of shutters and curtains, so as to exclude any

light, for the illumination must all be from one source.

If a background is used, and the amateur is fortunate enough to have the use of a hinged frame like an ordinary clothes-horse, he arranges his apparatus and subject as shown in the diagram.



In posing the subject, there is room for the exercise of much taste and artistic skill; and in lighting opportunity is given for the display of the best of judgment. Seek to photograph your friend in a characteristic attitude. Sometimes this will be standing, sometimes sitting; while at others, reading a book or a letter, or even writing at a table, makes a suitable pose. Then there are characters in history and fiction which one can represent by

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appropriately dressing and posing the figure. There is no end to the pictures which one can make with the camera in a home-made studio.

The first object, of course, in photographing one's friends is to obtain a characteristic likeness, and in this respect the amateur should be able to obtain a more satisfactory portrait than even the most skilful professional; for the amateur knows his friend—what pose and expression are most characteristic—while the professional cannot be expected to bring out the individuality of his subject on but a few moments' acquaintance. Then, too, the self-conscious expression which a subject is very likely to assume when seated before a camera in the professional's studio is not so often seen in a portrait made at home among familiar surroundings. Let the subject be dressed in ordinary clothes, and have the hair arranged in the usual way. The plainer the clothes the more effective will be the portrait, for, like fancy backgrounds, elaborate costumes sometimes attract more attention than the face, which should be, of course, the most prominent part of the portrait. A plain sitting pose, showing head and shoulders, is, as a rule, most satisfactory, especially for begin-

ners. Such a pose is easier to light, and requires less skill in the arrangement of details.

The camera which we have used in the field will answer all purposes for home portraiture, though a regular studio camera, with an adaptable rolling stand made especially for portrait work, is more convenient, of course. The lens which we have been using will also answer for portrait-making, for it is a long-focus one and possesses what is called a "flat" field. If a wide-angle lens had been used for landscape purposes, we should have been obliged to procure another one for portrait-making. The single-view lens which came with our outfit, however, does fairly good work in both departments of photography.

When the subject is posed in a natural position, with the best side of his or her face turned toward the light, we are ready to focus. This done, the plate-holder is inserted as before, the lens capped, and the slide withdrawn. We are now ready for the exposure, and here twenty or twenty-five seconds will be required; the exact length of exposure must be determined by experience, as in the case of landscape-making. It is well to expose both plates on the subject, giving one a little

longer time than the other and slightly changing the pose, so that there will be two chances of success and a choice in the position of the subject.

A group of two or more figures is managed in much the same way, so far as lighting and posing are concerned; but if the group should become larger than this, it is better to photograph it out-of-doors, using the plain side of a house for a background, and photographing when that side is in shadow. The people composing a group should be arranged in the general form of a pyramid. They should not all gaze directly at the camera, or, indeed, at any one point. Each one should be looking in the most natural way, and be in a characteristic pose, so far as is possible. Let there be some prominent central idea in the posing when the group is not too large, and the result will be a picture, as well as a number of individual portraits in one photograph. In making groups, as in photographing separate individuals, the taste of the amateur will suggest and direct; and he should be sure that he is master of ceremonies, for if every member of a group should carry out his or her ideas the picture would present a rather disconnected appearance. You alone can judge of the

effect as a whole, as you alone see it on the ground glass.

Developing and printing a portrait negative differs in no essential way from the same processes in connection with a landscape plate, which we have already learned how to make from beginning to end. But a portrait negative is sometimes "retouched" after it has been developed and fixed. This should never consist of more than merely touching out the imperfections in the plate with an ordinary lead pencil. Over-retouching is not artistic, and is more objectionable than no retouching at all. Indeed, many portraits which the amateur will make are much better if not retouched at all.

In printing, a paper vignette which cuts off the sides of a negative and allows the portrait to gradually shade off into whiteness sometimes produces an agreeable effect. The face is prominently brought out and the surroundings are softly shaded off into the background. Portraits appear best when mounted on neat white cards without gilt edges or anything to detract from the likeness itself.



THE DIVER BY LOUIS MELDON



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CHAPTER IX.

INSTANTANEOUS PHOTOGRAPHY.

In the practice of instantaneous photography there is perhaps more genuine fun to be had than in any other branch of amateur picture-taking. The same camera which has been used for landscape will serve for photographing instantaneously, and the same lens also will answer quite well under the most favorable circumstances; for the modern dry plate is so extremely sensitive that in a fair amount of light even a slow lens will succeed in making an instantaneous photograph. But a special hand-camera like the one shown in the chapter on apparatus will be found much more convenient for this work, and, with its improved and quickworking lens, will, of course, produce better results.

If the day is dark, or the moving object is passing very rapidly before the camera, so that an extremely short exposure is required, a lens termed a rapid "rectograph" or "rectilinear," consisting of a "double combination," is absolutely required. These more costly lenses are fitted with

an exposing shutter, by which the quickest exposure can be made automatically. They are also arranged so that longer exposures may be given when desirable, as in photographing landscapes or architectural subjects; thus, a good instantaneous lens supplied with an improved exposing shutter will answer for instantaneous purposes, portraiture, landscaping, and other kinds of photographic work.

To fit a landscape or portrait lens for instantaneous purposes, we must apply it with a quick exposing shutter. There are many kinds in the market, of various designs and prices, but the simple gravity or "drop" shutter will answer all purposes very well, at least in the beginning of instantaneous work. For this work, however, I strongly urge procuring a fine lens with an automatic exposing shutter.

When a tripod camera is used for instantaneous work, a "finder" should always be affixed to the box on its top, for it is not easy to quickly move a camera on a tripod so as to catch a fleeting object exactly on the middle of the plate. The finder, or "view-meter," as it is sometimes called, shows one exactly when the moving subject is opposite the middle of one's plate, so that it is only necessary

to release the shutter in order to catch the picture as securely as if the subject were stationary. "Finders" are always put on hand cameras.

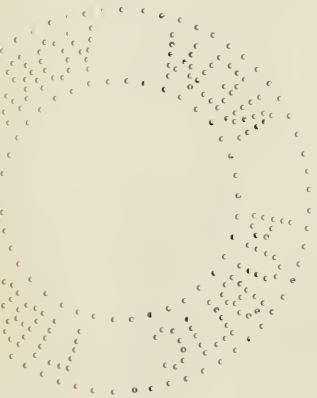
Let us now see wherein this process differs, if at all, from the other branches of photographic work. As has already been said, unless our lens is a very quick-working one, strong sunlight and clear atmosphere are necessary to make good instantaneous photographs. The light must fall from behind the camera full upon the object before it, so as to give the strongest illumination. The lens must have the largest opening possible, so as to admit the greatest amount of light, and the dry plate must be extremely sensitive. The developer described in Chapter III will be found to work as well with instantaneously exposed plates as with those which have received a longer exposure, and the beginner, at least, had better use the developer he has become accustomed to. In developing instantaneous negatives we must proceed as if treating an under-exposed plate, using rather more of the "B" solution than of the "A" solution. Sometimes a preliminary immersion of the plate in "B" solution and water before the "A" solution has been added is advantageous. The "A" solution can then be added, and, as the development pro-

gresses, increased until a full and proper density has been obtained on the negative. The fixing of the negative differs in no way, of course, from the process as applied to other negatives; and the printing, toning, and subsequent treatment of prints are also the same.

Instantaneous photography is but a few years old. The introduction of gelatine dry plates about fifteen years ago made it possible. Before that time, several seconds was considered a very short time for the camera to make a picture; now photographs are made in the infinitesimal fraction of a second. With the quickest-working lenses and the most sensitive plates, it is not even necessary that the light be strong or the atmosphere clear. Good instantaneous photographs have been made on dark days, and even during a gentle rain. By means of the magnesium "flash" light, daylight is not even necessary, for its intense blue light is sufficient to illuminate scenes at night, and in dark places where the sun's rays never penetrate. But of this interesting development of modern photography we must speak in a separate chapter. Having learned how to make instantaneous photographs by daylight, we shall be the better prepared to take up this wonderful process.



HALLOWE'EN EVE BY C. FRANCIS JENKINS




ARY

CHAPTER X.

FLASH-LIGHT PHOTOGRAPHY.

ONE of the most fascinating branches of amateur photography is that which was made possible by the introduction of burning magnesium as a source of photographic light.

Magnesium metal in the form of coiled wire or ribbon has been used for a number of years for making photographs in dark places, such as mines, caves, etc., but the method was quite difficult, and required a prolonged exposure in the camera.

Electric light has also been used as a substitute for the rays of the sun, but it required expensive apparatus and is much less powerful in its photographic action than the intense blue flash from the powdered magnesium metal.

Since the introduction of magnesium metal as a source of actinic or photographic light, several years ago, many improvements have been made upon the method of applying it, so that now any amateur can make instantaneous photographs in

this way without any trouble whatever. The powdered magnesium can be purchased in the form of "cartridges" containing the proper quantity for an exposure. A pistol has been devised for "shooting" the flash-light on the subject to be photographed, whether it be a man walking in the street at night or merely a dark place which the sun cannot illuminate. Any camera can be used for this purpose, though a hand camera will be found most convenient. Portraits also in one's home may very readily be made by these means—family groups, small dinner and card parties, and other social gatherings—and a great many subjects which were out of the question before the magnesium flash-light was suggested.

Considerable care must be given in lighting a portrait by the magnesium flash in order to produce roundness of effect and avoid the strong contrasts and harsh appearance which we so often see in flash-light pictures. One should place the magnesium at least five feet distant from the subject. The nearer it is to the source of light, the sharper are the contrasts, of course. But, on the other hand, the further we remove the light, the weaker will be its illuminating power. It is therefore bet-

ter to place the magnesium to be ignited from five to eight feet distant from the subject, and soften its effect by interposing between it and the sitter a screen of white tissue paper. The background must be removed some distance from the subject so that the strong shadows from the sitter will not fall upon it. The magnesium should be ignited a little above the camera, and removed far enough from the apparatus so that no light can enter the lens. Sometimes it will be necessary to use a reflecting screen similar to the one described in the chapter on Portraiture.

In lighting groups for photographing by means of the magnesium flash, it is better to place the light on the extreme right or left of the subject than immediately in its front. When very large groups are photographed, it is sometimes necessary to light from both sides of the group, the light that falls on one side being made much stronger, of course, than upon the other, so as to produce agreeable shading. This method of lighting is also best when a large interior is desired to be photographed at night, and for such purposes some one of the many ingenious magnesium lamps which have been placed upon the market will be

found more convenient than the simple "cartridges."

Of course a rapid lens and a very sensitive plate must be employed, and the development will be conducted as for an ordinary instantaneous picture. In focusing it will be found convenient to employ a burning candle, which may be placed at that part of the room where the greatest distinctness is desired in the photograph, or close to the sitter's face, as the case may be. As soon as sharp focus is obtained, the candle is of course removed, the lens is capped, and the slide withdrawn from the plate-holder ready for the flash. The photographer is now in total darkness, the cap is removed from the lens, and the magnesium powder, in the form of a cartridge or in a lamp as the case may be, is ignited. A lightning-like flash of the most intense blue light follows and endures for perhaps a thirtieth of a second. The lens is then recapped, the slide reinserted, and the exposed plate is ready for development.

It will not be necessary to employ a special developer for this kind of work, though the one recommended by Mr. S. R. Stoddard, who has

been very successful in flash-light work, is so well adapted for the purpose that it is given here.

No. 1.

Distilled or ice water	10 ounces
Citric acid	1 drachm
Sulphite of soda, crystals	4 ounces
Pyrogallol (Schering's resublimed)	1 ounce

Add water to make the solution up to sixteen fluid ounces.

No. 2.

Water	10 ounces
Sulphite of soda, crystals	2 "
Carbonate of soda, crystals (or dry granular, 1 ounce)	2 "
Potash carbonate	1 "

Dissolve, and add water to make sixteen fluid ounces.

A third solution, composed of

Bromide of potassium	½ ounce
Water	5 ounces

should also be prepared for "restraining purposes."

The developing solution is composed by mixing from 1½ to 2½ drachms of No. 1 solution with from 2 to 3 ounces of the No. 2 solution. More or less of the No. 1 or No. 2 is added as the exigencies of development may require. If the image does

not readily appear when the plate has been immersed in the developing solution, a little more of the No. 2 solution should be added.



If it comes up too quickly, a few drops of the third solution should be mixed with the developer. The plate is, of course, fixed as usual in a hypo-sulphite of soda solution, after which, and a thorough washing in running water, it is dried, and is then ready for the printing frame.

A very simple device for exposing flash pictures is the "Wand," shown in the side illustration, while more elaborate lamps are required for mak- flash-light pictures in larger rooms.



"HARK! THE LARK AT HEAVEN'S GATE SINGS."

BY ALEX. KEIGHLEY


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CHAPTER XI.

COMPOSITE PHOTOGRAPHY.

FRANCIS GALTON, in 1877, explained to a subsection of the British Association a method by which he had obtained an average type of a group of people by blending in a certain manner the photographic portraits of the individuals.

This was the beginning of composite photography. The original method of Galton was soon greatly modified and improved, and composite photography became very popular. As the process was simplified, composite photographs were made in great numbers and of various subjects. It was a common thing for the graduating class in the higher schools and colleges to have a composite made from their portraits before separating for their homes. Thus each member of the class would have a picture of all the other members in one portrait, or, more truly, perhaps, a characteristic portrait of the entire class. The average facial type of certain professions and occupations was obtained by means of composite photography,

and very interesting were the attempts made to show the typical American lawyer, clergyman, doctor, legislator, or actor. Some of the results obtained were very curious, as for instance, the composite of a class of girls blended with a similar photograph of a group of young men in order to show the prevailing characteristic of the young American student.

A rather comical story is told of one young man who was shown a photograph of a young lady which seemed to impress him very much. The expression of the countenance in the portrait denoted a strong will, yet a gentle disposition. It was the face of a young lady whom one would like to know.

"Who is the original of this portrait?" the young man inquired.

"The graduating class of Smith College, Northampton," was the reply.

It was a composite photograph, and the admiring young man awoke regretfully to the fact that there was in reality no such lady as the one whose face had so strongly impressed him—or, rather, that there were forty-nine of her!

Another instance is told of a young lady who,

on seeing a composite photograph of a small circle of friends of which she was a member, exclaimed: "It is so charming to enjoy the portrait of somebody who is all one's intimate friends at once!"

An interesting composite photograph may be made by blending the various portraits of one's self made at different periods. Thus a slightly idealized likeness is obtained, for the inevitable conscious expression is done away with in blending the various portraits.

There is no end of subjects to which composite photography may be applied, and the results may often be of great value to science. It has been suggested that the process might be used with advantage in obtaining the types of animal species and standards of different breeds; also that a composite photograph would be more valuable than the most expert testimony in deciding the genuineness of a suspected signature, for the doubtful autograph could be compared with a composite of several which were known to be genuine, and the difference, if any, would then be apparent.

Composites of small groups are not so valuable as an average type, of course, as those which are

made of larger numbers. Composite photography is of the most value in securing an average type and generalization of the prevailing race or class characteristics.

When the prominent features in a group of people are entirely unlike, the composite photograph of that group will result in a blurred mass without many well-defined lines. If, on the other hand, it were possible for all of the faces of a group to be exactly the same in the striking features, the result would be a clear and well-defined portrait, as if made of one person. It is therefore apparent that in proportion as the characteristic features of a group are similar or unlike, the resulting composite photograph will be clearly defined or blurred. That member of the group who bears the greatest resemblance to the composite portrait comes nearest, of course, to having the average typical face; while the one who is entirely unlike the blended mass of portraiture has features which are distinctly different from all the others in the combination.

It is not difficult to make composite photographs. There are several methods by which the work can be done. That first explained by

Francis Galton consisted in hanging a number of portraits one in front of the other "in such a way that the eyes of all the portraits shall be as nearly as possible superimposed." He first focused his camera upon the top portrait, and made a photograph of it; then, by successively removing the portraits from the pin which secured them, the likenesses of all were imposed in turn upon the same part of the sensitive plate, and a composite photograph of the entire group was secured.

This method required accurate apparatus, which was rather expensive and therefore could not be used by most amateurs. Mr. Rockwood, who has successfully made many composite photographs, especially of graduating classes, describes his method of work as follows. He is speaking of a composite of nine young ladies, members of a literary club in New York.

"I reduced the power of light," he says, "so as to make necessary an exposure of eighteen seconds.

"I first drew upon the ground glass a fine perpendicular pencil line, which served as a central line at the head. Across and at right angles to

this line I drew two others, an inch and a quarter apart, one of which ran through the line of the month and the other through the eye at the caruncula, or at the joining of the upper and lower cartilages. These lines were arbitrary, and the image was adjusted to them.

"Of course there is quite a variation in the distances between these two lines in the human head; therefore the camera had to be carefully adjusted after each exposure. As it was very difficult to do this by hand, I constructed adjustable boards hinged at one side with fine screws so placed under the camera as to elevate or depress it, and another screw to move the whole camera and bed-plate forward or backward, until these distances between the eyes and mouth were made to correspond with the standard. I then made a pendulum by a weight on the end of a string about forty inches long, practically giving one second to a motion of oscillation. This I found to be more practicable than a watch.

"Starting my pendulum, the impressions were made in quick succession. Of course the slide was returned to the holder after each exposure,

and a new focus of adjustment of the succeeding sitter made. The only modification to the final picture consisted in uniting the white collars or neckwear into one. I think it would be best in future experiments to have a dark or black silk kerchief with which to cover the white neck-draping, which would give a simple, uniform effect to the upper part of the body."

Another simple yet accurate way of making a composite is to superimpose one portrait upon another until all the pictures of a group are printed upon one piece of paper from the various negatives. This print is then finished in the ordinary way, and shows the average of all facial developments and physical peculiarities of the members composing the group.

In printing from various negatives on one piece of paper, it has been suggested to place the negatives all together, one on top of another, accurately superimposed in one large specially made frame deep enough to hold all, and then print through all the negatives at one time on one sheet of paper beneath.

The actual photographing in any case is, of course, accomplished in the usual way, and the

development and printing is the same as in other branches of photographic work.

But the greatest accuracy must be maintained in posing the subjects, so that the prominent features of all will fall exactly upon the same place in the plate, and in giving precisely the same length of exposure to all the subjects. The sum of the various individual exposures must equal the length required to make one good negative under the same circumstances.

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UNITED STATES WEIGHTS AND MEASURES.

ACCORDING TO EXISTING STANDARDS.

LINEAL.

	Inches.	Feet.	Yards.	Rods.	Fur's.	Mile.
12 inches = 1 foot.	12 =	1				
3 feet = 1 yard.	36 =	3 =	1			
5.5 yards = 1 rod.	198 =	16.5 =	5.5 =	1		
40 rods = 1 furlong.	7,920 =	660 =	220 =	40 =	1	
8 furlongs = 1 mile.	63,360 =	5,280 =	1,760 =	320 =	8 =	1

SURFACE—LAND.

	Feet.	Yards.	Rods.	Roods.	Acres.
144 sq. ins. = 1 sq. ft.	9 =	1			
9 sq. ft. = 1 sq. yard.	272.25 =	30.25 =	1		
30.25 sq. yds. = 1 sq. rod	10,890 =	1,210 =	40 =	1	
40 sq. rods = 1 sq. rood.	43,560 =	4,840 =	160 =	4 =	1
4 sq. roods = 1 acre.	27,878,400 =	3,097,900 =	102,400 =	2,560 =	640
640 acres = 1 sq. mile.					

VOLUME—LIQUID.

4 gills = 1 pint.
2 pints = 1 quart.
4 quarts = 1 gallon.

Gills.	Pints.	Gallons.	Cub. In.
32 =	8 =	1 =	231

FLUID.

Gallon.	Pints.	Ounces.	Drachms.	Minims.	Cubic Centimeters.
1 =	8 =	128 =	1,024 =	61,440 =	3,785.435
	1 =	16 =	128 =	7,680 =	473.179
		1 =	8 =	480 =	29.574
			1 =	60 =	3.697

16 ounces, or a pint, is sometimes called a fluid pound.

TROY WEIGHT.

Pound.	Ounces.	Pennyweights.	Grains.	Grams
1 =	12 =	240 =	5,760 =	373.24
	1 =	20 =	480 =	31.10
		1 =	24 =	1.56

APOTHECARIES' WEIGHT.

lb.	℥	ʒ	℈	gr.	
Pound.	Ounces.	Drachms.	Scruples.	Grains.	Grams.
1 =	12 =	96 =	288 =	5,760 =	373.24
	1 =	8 =	24 =	480 =	31.10
		1 =	3 =	60 =	3.89
			1 =	20 =	1.30
				1 =	.06

The pound, ounce, and grain are the same as in Troy weight.

AVOIRDUPOIS WEIGHT.

Pound.	Ounces.	Drachms	Grains (Troy).	Grams.
1 =	16 =	256 =	7,000 =	453.60
	1 =	16 =	437.5 =	28.35
		1 =	27.34 =	1.77

"UNIFORM SYSTEM" NUMBERS FOR STOPS FROM *f*/1 TO *f*/100.

In the following table Mr. S. A. Warburton has calculated the exposure necessary with every stop from *f*/1 to *f*/100 compared with the unit stop of the "uniform system" of the Photographic Society of Great Britain. The figures which are underlined show in the first column what *f*/*a* must be in order to increase the exposure in geometrical ratio from *f*/4, the intermediate numbers showing the uniform system number for any other aperture.

f	U. S. No.	*f*	U. S. No.	*f*	U. S. No.
1	1/16	15	14.06	58	210.25
		16	16	59	217.56
1¼	.097			60	225.00
1 414	1/8			61	232.56
		17	18 06	62	240.25
1½	.140	18	20.25	63	248.06
1¾	.191	19	22.56	64	256
2	.¼	20	25.00		
		21	27.56		
2¼	.316	22	30.25	65	264.06
2½	.390	22.62	32	66	272.25
2.828	½			67	280.56
		23	33.06	68	289.00
2¾	.472	24	36.00	69	297.56
3	.562	25	39.06	70	306.25
3¼	.660	26	42.25	71	315.06
3½	.765	27	46.56	72	324.00
3¾	.878	28	49.00	73	333.06
4	1.00	29	52.56	74	342.25
		30	56.25	75	351.56
4¼	1.12	31	60.06	76	361.00
4½	1.26	32	64	77	370.56
4¾	1.41			78	380.25
5	1.56	33	68.06	79	390.06
5¼	1.72	34	72.25	80	400.00
5½	1.89	35	76.56	81	410.06
5.656	2	36	81.00	82	420.25
		37	85.56	83	430.56
5¾	2.06	38	90.25	84	440.00
6	2.25	39	95.06	85	451.56
6¼	2.44	40	100.00	86	462.25
6½	2.64	41	105.06	87	473.06
6¾	2.84	42	110.25	88	484.00
7	3.06	43	115.56	89	495.06
7¼	3.28	44	121.00	90	506.25
7½	3.51	45	126.56	90.50	512
7¾	3.75	45.25	128		
8	4.				
		46	132.25	91	517.56
8¼	4.25	47	138.06	92	529.00
8½	4.51	48	144.00	93	540.56
8¾	4.78	49	150.06	94	552.25
9	5.06	50	156.25	95	564.06
9¼	5.34	51	162.56	96	576.00
9½	5.64	52	169.00	97	588.06
9¾	5.94	53	175.56	98	600.25
10	6.25	54	182.25	99	612.56
11	7.56	55	189.06	100	625.00
11.31	8	56	196.00		
12	9.00	57	203.06		
13	10.56				
14	12.25				

USUAL SIZES OF FRENCH, GERMAN AND ITALIAN DRY PLATES.

French and German.	*Inches.*
6½x 9 Cm	2.5x 3.6
9 x12 "	3.6x 4.7
12 x15 "	4.7x 5.9
13 x18 "	5.1x 7.0
12 x20 "	4.7x 7.8
15 x21 "	5.9x 8.2
15 x22 "	5.9x 8.6
18 x24 "	7.2x 9.4
21 x27 "	8.2x10.6
24 x30 "	9.4x11.8
27 x33 "	10.6x12.9
27 x35 "	10.6x13.7
30 x40 "	11.8x15.7
40 x50 "	15.7x19.6
50 x60 "	19.6x23.6

Italian.	*Inches.*
9x12 Cm	3.6x 4.7
12x16 "	4.7x 6.3
12x18 "	4.7x 7.2
13x18 "	5.1x 7.0
12x20 "	4.7x 7.8
18x24 "	7.0x 9.4
21x27 "	8.2x10.6
24x30 "	9.4x11.8
27x33 "	10.6x12.9
30x36 "	11.8x14.1
40x50 "	15.7x19.6
50x60 "	19.6x23.6

SIZES OF GLASS, MOUNTS, PAPER, ETC.

Petite cards	1⅝x3⅛
One-ninth plate	2 x2½
One-sixth plate	2¾x3¼
One-fourth plate	3¼x4¼
Half-plate	4¼x5½ and 4¼x6½
Half-plate (English)	4¾x6½
Whole plate (4-4)	6½x8½
Extra 4-4	8 x10

Other sizes are expressed by inches.

Sizes of Mounts.

Stereoscopic	3½x7, 4x7, 4¼x7, 4½x7, 5x8.		
Victoria	3¼x5	Minette	1½x2⅜
Imperial	7⅞x9⅞	Card	2½x4⅛
Boudoir	5¼x8½	Cabinet	4¼x6½
Panel	4 x8¼	Promenade	4⅛x7⅛

Sizes of Albumen Paper.

18x22¾, 20½x24½, 22x36, 26x40, 27x42.

Size of blotting paper 19x24

METRIC SYSTEM OF VOLUMES AND WEIGHTS

MEASURES OF VOLUME.

Denominations and Values.			Equivalents in Use.	
Names.	No. of Liters.	Cubic Measures.	Dry Measure.	Wine Measure.
Kiloliter or stere.....	1000	1 cubic meter	1.308 cubic yds	264.17 gals.
Hectoliter..	100	$\frac{1}{10}$ cubic meter	2 bush'ls and 3.35 pecks	26.417 gals.
Dekaliter ..	10	10 cubic decimeters	9.08 quarts	2.6417 gals.
Liter.....	1	1 cubic decimeter	.908 quart	1.0567 qts.
Deciliter...	$\frac{1}{10}$	$\frac{1}{10}$ cubic decimeter	6.1023 cu. inches	.845 gill
Centiliter...	$\frac{1}{100}$	10 cubic centimeters	.6102 cubic inch	.338 fl oz.
Milliliter...	$\frac{1}{1000}$	1 cubic centimeter	.061 cubic inch	.27 fl.drm.

WEIGHTS.

Denominations and Values.			Equivalents in Use.
Names.	No. of Grams.	Weight of Volume of Water at its Maximum Density.	Avoirdupois Weight.
Millier or Tonneau..	1,000.000	1 cubic meter	2204.6 pounds
Quintal.....	100,000	1 hectoliter	220.46 pounds
Myriagram.....	10,000	10 liters	22.046 pounds
Kilogram or Kilo...	1,000	1 liter	2.2046 pounds
Hectogram.....	100	1 deciliter	3.5274 ounces
Dekagram	10	10 cubic centimeters	.3527 ounce
Gram.....	1	1 cubic centimeter	15.432 grains
Decigram.....	$\frac{1}{10}$	$\frac{1}{10}$ cubic centimeter	1.5432 grains
Centigram.....	$\frac{1}{100}$	10 cubic millimeters	.1543 grain
Milligram.....	$\frac{1}{1000}$	1 cubic millimeter	.0154 grain

The unit of capacity is the cubic decimeter or LITER, and the series of measures is formed in the same way as in the case of the table of lengths. The cubic meter is the unit of measure for solid bodies, and is termed STERE. *The unit of weight* is the GRAM, which is the weight of one cubic centimeter of pure water weighed in a vacuum at the temperature of 4 degrees Centigrade or 39.2 degrees Fahrenheit, which is about its temperature of maximum density. In practice, the term cubic centimeter, abbreviated c.c., is generally used instead of milliliter, and cubic meter instead of kiloliter.

THE CONVERSION OF METRIC INTO AMERICAN MEASURE.

By Nelson B. Sizer, B.Sc., M.D.

[From *The Photographic Times*, August 14, 1891.]

The following table is computed true to the nearest half grain or minim, as the case may be, so it will prove a sufficiently near approximation to the required metric equivalents.

U. S. P. Standard.

Gram, or c.cm.	Grains.	Minims.	Gram, or c.cm.	Grains.	Minims.
1	15½	16¼	15	231½	244
2	31	32½	16	247	260
3	46	49	17	262	276
4	62	65	18	278	292½
5	77	81	19	293	309
6	93	97½	20	308½	325
7	108	114	30	463	487½
8	123½	130	40	617	650
9	139	146	50	771½	813
10	154	162½	60	926	975½
11	170	179	70	1,080	1,138
12	185	194	80	1,234½	1,300½
13	201	211	90	1,389	1,463
14	216	227½	100	1,543	1,625½
..	...	...	1,000	15,432⅓	16,256⅓
..	...	...	-	1 kilo	liter

The "kilo" or kilogram, the 1000-gram weight, is equal to 32 ounces 72 $\frac{8}{10}$ grains "Troy or Apothecaries'" weight, or 2 pounds 3 ounces 119$\frac{7}{10}$ grains Avoirdupois.

The "liter" or 1,000 cubic centimeters, or bulk of water that weighs 1 kilo, is equal to 2 pints 1 fluid ounce and 415$\frac{8}{10}$ minims, U. S. P. Standard, or our glass graduates as commonly sold by reliable houses.

The grains and minims are easily reduced to fluid drams and fluid ounces, or drams and ounces Troy, by my readers, if they will only remember that 60 grains or minims go to the solid or fluid dram, and 480 grains or minims, or 8 drams solid or fluid, go to each U. S. P. ounce, solid or fluid.

Thus the table gives the value of 90 grams as 1389 grains, of 90 cubic centimeters as 1463 minims. How many ounces in each?

Dividing 1389 by 60 for drams, we have 23 drams 9 grains. As 8 drams go to the ounce, there are two ounces in the 23 drams and 7 drams over, so we have—in 1389 grains there are 2 ounces 7 drams 9 grains, In the same way we find 3 fluid ounces and 23 minims over to be the value of 90 cubic centimeters or 1463 minims.

PROF. BURTON'S TABLE OF COMPARATIVE EXPOSURES.

Apertures Calculated on the Standard System of the Photographic Society.	Sea and Sky.	Open Landscape.	Landscape with Heavy Foliage in Foreground.	Under Trees, up to		Fairly Lighted Interiors.		Badly Lighted Interiors, up to		Portraits in bright diffused Light out of Doors.	Portraits in Good Studio Light.		Portraits in Ordinary Room.	
	sec.	sec.	sec.	min.	sec.	min.	sec.	hrs.	min.	sec.	min.	sec.	min.	sec.
No. 1, or $\frac{f}{4}$	$\frac{1}{160}$	$\frac{1}{50}$	$\frac{1}{8}$	0	10	0	10	0	2	$\frac{1}{6}$	0	1	0	4
No. 2, or $\frac{f}{5.657}$...	$\frac{1}{80}$	$\frac{1}{25}$	$\frac{1}{4}$	0	20	0	20	0	4	$\frac{1}{3}$	0	2	0	8
No. 4, or $\frac{f}{8}$	$\frac{1}{40}$	$\frac{1}{12}$	$\frac{1}{2}$	0	40	0	40	0	8	$\frac{2}{3}$	0	4	0	16
No. 8, or $\frac{f}{11.314}$..	$\frac{1}{20}$	$\frac{1}{6}$	1	1	20	1	20	0	16	$1\frac{1}{3}$	0	8	0	32
No. 16, or $\frac{f}{16}$	$\frac{1}{10}$	$\frac{1}{3}$	2	2	40	2	40	0	32	$2\frac{2}{3}$	0	16	1	4
No. 32, or $\frac{f}{22.627}$.	$\frac{1}{5}$	$\frac{2}{3}$	4	5	20	5	50	1	4	$5\frac{1}{3}$	0	32	2	8
No. 64, or $\frac{f}{32}$	$\frac{2}{5}$	$1\frac{1}{3}$	8	10	40	10	40	2	8	$10\frac{2}{3}$	1	4	4	16
No. 128, or $\frac{f}{45.255}$	$\frac{4}{5}$	$2\frac{2}{3}$	16	21	20	21	20	4	16	21	2	8	8	32
No. 256, or $\frac{f}{64}$...	$1\frac{3}{5}$	$5\frac{1}{3}$	32	42	40	42	40	8	32	42	4	16	17	4

TABLE FOR ENLARGEMENT AND REDUCTION.

Computed for Centimeters or Inches.

Equivalent Focus of the Lens	Distances of the Object and the Ground Glass Screen from the Center of the Objective.																								
	1*f*	2*f*	3*f*	4*f*	5*f*	6*f*	7*f*	8*f*	9*f*	10*f*	11*f*	12*f*	13*f*	14*f*	15*f*	16*f*	17*f*	18*f*	19*f*	20*f*	21*f*	22*f*	23*f*	24*f*	25*f*
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130
	10	7.5	6.7	6.2	6	5.8	5.7	5.6	5.6	5.5	5.5	5.4	5.4	5.4	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2	5.2
6.....	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144	150	156
	12	9	8	7.5	7.2	7	6.9	6.8	6.7	6.6	6.5	6.5	6.5	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.2
7. ...	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168	175	182
	14	10.5	9.3	8.8	8.4	8.2	8	7.9	7.8	7.7	7.6	7.6	7.5	7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3
8.....	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192	200	208
	16	12	10.7	10	9.6	9.3	9.1	9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.5	8.5	8.4	8.4	8.4	8.4	8.4	8.3	8.3	8.3
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180	189	198	207	216	225	234
	18	13.5	12	11.3	10.8	10.5	10.3	10.1	10	9.9	9.8	9.8	9.7	9.6	9.6	9.6	9.5	9.5	9.5	9.5	9.4	9.4	9 4	9.4	9 4
10.....	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
	20	15	13.3	12.5	12	11.7	11.4	11.3	11.1	11	10.9	10.8	10.8	10.7	10.7	10.6	10.6	10.6	10.5	10.5	10.5	10.5	10.4	10.4	10.4
11.....	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220	231	242	253	264	275	286
	22	16.5	14.7	13.8	13.2	12.8	12.6	12.4	12.2	12.1	12	11.9	11.8	11.8	11.7	11.7	11.6	11.6	11.6	11.6	11.5	11.5	11.5	11.5	11.4
12.....	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312
	24	18	16	15	14.4	14	13.7	13.5	13.3	13.2	13.1	13	12.9	12.9	12.8	12.7	12.7	12.7	12.6	12.6	12.6	12.5	12.5	12.5	12.5
13.....	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260	273	286	299	312	325	338
	26	19.5	17.3	16.3	15.6	15.2	14.9	14.6	14.4	14.3	14.2	14.1	14	13.9	13.9	13.8	13.8	13.7	13.7	13.7	13.6	13.6	13.6	13.5	13.5
14.....	28	42	56	70	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280	294	308	322	336	350	364
	28	21	18.7	17.5	16.8	16.3	16	15.8	15.6	15.4	15.3	15.2	15.1	15	14.9	14.9	14.8	14.8	14.7	14.7	14.7	14.6	14.6	14.6	14.6
15.....	30	45	60	75	90	105	120	135	150	165	180	195	110	225	240	255	270	285	300	315	330	345	360	375	390
	30	22.5	20	18.8	18	17.5	17.1	16.9	16.7	16.5	16.4	16.3	16.2	16.1	16	15.9	15.8	15 8	15.8	15.7	15.7	15.7	15.7	15.6	15.6

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